Center Innovation Fund: KSC CIF

Effect of the Mars Environment on Spacecraft Materials

Completed Technology Project (2018 - 2019)

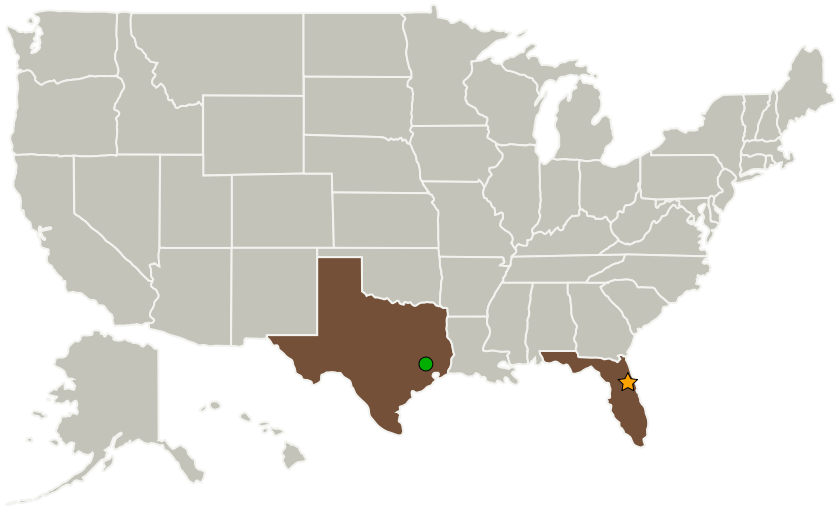
Project Introduction

The goal is to develop a test methodology for spacecraft material corrosion resistance; evaluate aerospace materials and surface treatments. This data will support materials selection recommendations for long-duration missions on Mars. Corrosion mechanism studies will be carried out using Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) in a simulated Mars atmospheric environment with gas mixture and temperature controls. The chemical interaction between spacecraft aluminum and the Martian regolith will also be investigated in the Mars chamber with UV radiation, Carbon Dioxide (CO2), Mars gas, and perchlorate brine exposure. Results will be a validated and refined material testing methodology for corrosion property testing. This theoretical study provides strong justification to conduct experimental work to investigate the interaction between spacecraft materials with simulated Martian environments to reduce Mars exploration costs.

Anticipated Benefits

This theoretical study provides strong justification to conduct experimental work to investigate the interaction between spacecraft materials with simulated Martian environments to reduce Mars exploration costs.

Primary U.S. Work Locations and Key Partners



Effect of the Mars Environment on Spacecraft Materials

Table of Contents

Effect of the Mars Environment on Spacecraft Materials

Completed Technology Project (2018 - 2019)

Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
Florida Institute of Technology	Supporting Organization	Academia	Melbourne, Florida
●Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations	
Florida	Texas

Project Transitions

March 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Center Innovation Fund: KSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

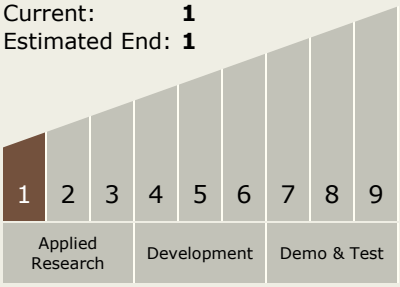
Barbara L Brown

Principal Investigator:

Luz M Calle

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **1**



Effect of the Mars Environment on Spacecraft Materials

Completed Technology Project (2018 - 2019)

March 2019: Closed out

Closeout Summary: This report presents the results of a one-year project, funded by NASA's Kennedy Space Center Innovation Fund in FY18, to conduct a theoretical study on the effect of the Mars environment on spacecraft materials. Corrosion resistance is one of the most important properties in selecting materials for landed spacecraft and structures that will support surface operations for the human exploration of Mars. Currently, the selection of materials is done by assuming that the corrosion behavior of a material on Mars will be the same as that on Earth. This is understandable since there is no data on the corrosion resistance of materials in the Mars environment. However, given that corrosion is defined as the degradation of a metal that results from its chemical interaction with the environment, it cannot be assumed that corrosion is going to be the same in both environments since they are significantly different. The goal of this research was to develop a systematic approach to understand corrosion of spacecraft materials on Mars by conducting a literature search of available data, relevant to corrosion in the Mars environment. This project was motivated by the suggestion, by a team of researchers, that some of the structural degradation observed on Curiosity's wheels may have been caused by corrosive interactions with the transient liquid brines, reported to be present on Mars, while the most significant damage was attributed to rock scratching. An extensive literature search, on data relevant to corrosion on Mars, confirmed the need to investigate the interaction between materials, used for spacecraft and structures designed to support long-term surface operations on Mars, and the Mars environment. Previous preliminary experiments, designed to look at the interaction between aerospace aluminum alloy (AA7075-T73) and the gases present in the Mars atmosphere, at 20oC and a pressure of 700 Pa, showed that there is an interaction between the small amount of oxygen present in the Mars gas and the alloy, when there is a scratch that removes the protective aluminum oxide film. Further studies are needed to consider many other important components of the Mars environment that can affect this interaction such as: the presence of brines, the interaction between these brines and materials, the effect of radiation on these interactions, and the possible catalytic effects of the clays present in the Martian regolith. This theoretical study provides strong justification to conduct experimental work to investigate the interaction between spacecraft materials with simulated Martian environments to reduce Mars exploration costs.

Project Website:

https://www.nasa.gov/directorates/spacetech/innovation_fund/index.html#.VC

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

Target Destination

Mars